

Terrain modelling in surveying and civil engineering

G Petrie and T J M Kennie*

This paper is a review of the application of terrain modelling to surveying and civil engineering. The first section considers the theoretical background to the subject and two distinct approaches are identified based on the use of either grid or randomly located heights data. The relative merits of each are discussed and the most frequently used algorithms for interpolation and contouring are examined. This is followed by a review of the characteristics of a selected number of terrain modelling and contouring packages. Five distinct groups of packages are identified. Finally, a review of applications is presented together with some views on the future trends in this field.

terrain modelling, civil engineering, landscape planning

Surface modelling is a general term used to describe the process of representing a physical or artificially created surface by means of a mathematical expression. Terrain modelling is one particular category of surface modelling which deals with the specific problems of representing the surface of the earth.

The term 'digital terrain model' was originally coined in 1958 by Miller and Laflamme¹. Since then, the subject has developed considerably and is currently an area of widespread activity in surveying, geology and geophysics, civil and mining engineering and other disciplines in the earth sciences.

The paper is divided into three distinct sections. The first section examines the theoretical background and considers the advantages and limitations of the various interpolation and contouring techniques which are used by the program packages described in the second section. The paper concludes by listing the range of projects where terrain modelling may be applied and considers the most likely trends for the future in this field.

THEORETICAL BACKGROUND

As the review in the later part of the paper will show, a very large number of program packages have been devised and written for terrain modelling applications in surveying and civil engineering. Each program package has been written independently and usually has been optimized for a specific

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application or for use on a specific computer or uses a different programming language, or has a distinctive user interface. However, in spite of this diversity, when their characteristics are analysed, it can be seen that basically they follow one or two main approaches (see Figure 1). Either they are based on, or make use of, height data which has been collected or arranged in the form of a regular (e.g. rectangular or square) grid or they are based on a triangular network of irregular size, shape and orientation, and use randomly-located height data.

Grid based terrain modelling

The first approach is in many ways the simplest, in that the data comprising the terrain model is measured or collected in the form of a regular grid. This is in widespread use, e.g. in the grid levelling of building sites carried out by surveyors and civil engineers and in the acquisition of profile data measured photogrammetrically in stereoplottling instruments, in the latter case, especially when derived automatically or semi-automatically during the production

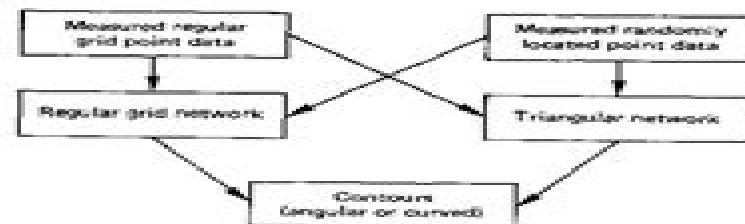


Figure 1. Overall relation between measured point data, networks and contours in terrain modelling

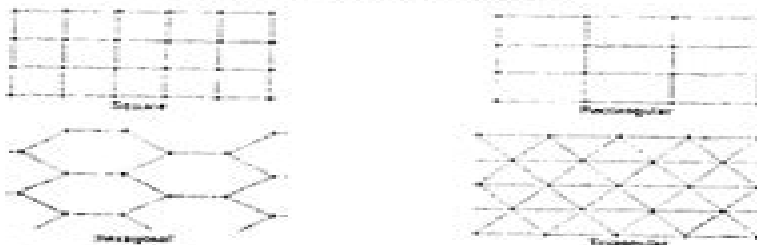


Figure 2. Regular grid patterns

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Terrain Modelling In Surveying And Civil Engineering:

Terrain Modelling in Surveying and Civil Engineering G. Petrie, T. J. M. Kennie, 1991 *Terrain Modelling in Surveying and Civil Engineering* G. Petrie, 1989-12-01 An examination of current developments in terrain modelling and its application to civil engineering design land and hydrographic surveying development planning and computer visualization for civil and military applications Engineering Surveying Technology T.J.M. Kennie, 2014-04-21 This book examines the major changes in the technology now used for the measurement and processing of topographic and non topographic spatial data with emphasis on the new and emerging technology and its applications Fundamental principles are introduced to explain the basic operation of different types of equipment **Short Course on Terrain Modelling in Surveying and Civil Engineering, 7-9 April, 1987, University of Surrey, Guildford, 3-5 September, University of Glasgow, Glasgow** Thomas J. M. Kennie, G. Petrie, 1987 Civil Engineer's Reference Book L S Blake, 1994-03-21 After an examination of fundamental theories as applied to civil engineering authoritative coverage is included on design practice for certain materials and specific structures and applications A particular feature is the incorporation of chapters on construction and site practice including contract management and control *Geographical Information Systems and Computer Cartography* Chris B. Jones, 2014-05-01 A concise text presenting the fundamental concepts in Geographical Information Systems GIS emphasising an understanding of techniques in management analysis and graphic display of spatial information Divided into five parts the first part reviews the development and application of GIS followed by a summary of the characteristics and representation of geographical information It concludes with an overview of the functions provided by typical GIS systems Part Two introduces co ordinate systems and map projections describes methods for digitising map data and gives an overview of remote sensing Part Three deals with data storage and database management as well as specialised techniques for accessing spatial data Spatial modelling and analytical techniques for decision making form the subject of Part Four while the final part is concerned with graphical representation emphasising issues of graphics technology cartographic design and map generalisation **Terrain Modelling in Surveying and Civil Engineering** University of Glasgow, University of Surrey, 1987 **An Introduction to Civil Engineering Surveying** J. Paul Guyer, P.E., R.A., 2020-12-14 Introductory textbook for graduate and undergraduate civil engineering students studying civil engineering surveying Here is what is covered 1 TOPOGRAPHIC SURVEYS OVERVIEW 2 SURVEY METHODS AND TECHNIQUES 3 SURVEY CONTROL MONUMENTS 4 FIELD DATA COLLECTORS AND COORDINATE GEOMETRY 5 HORIZONTAL CONTROL SURVEY TECHNIQUES 6 VERTICAL CONTROL SURVEY TECHNIQUES 7 ACCURACY STANDARDS FOR LAND SURVEYS 8 GEODETIC REFERENCE SYSTEMS 9 PLANNING AND CONDUCTING CONTROL AND TOPOGRAPHIC SURVEYS

Geomorphometry Tomislav Hengl, Hannes I. Reuter, 2008-09-25 Geomorphometry is the science of quantitative land surface analysis It draws upon mathematical statistical and image processing techniques to quantify the shape of earth s

topography at various spatial scales The focus of geomorphometry is the calculation of surface form measures land surface parameters and features objects which may be used to improve the mapping and modelling of landforms to assist in the evaluation of soils vegetation land use natural hazards and other information This book provides a practical guide to preparing Digital Elevation Models DEM for analysis and extracting land surface parameters and objects from DEMs through a variety of software It further offers detailed instructions on applying parameters and objects in soil agricultural environmental and earth sciences This is a manual of state of the art methods to serve the various researchers who use geomorphometry Soil scientists will use this book to further learn the methods for classifying and measuring the chemical biological and fertility properties of soils and gain a further understanding of the role of soil as a natural resource Geologists will find value in the instruction this book provides for measuring the physical features of the soil such as elevation porosity and structure which geologists use to predict natural disasters such as earthquakes volcanoes and flooding Technical details on a variety of software packages allow researchers to solve real life mapping issues Provides soil and agronomy researchers best practice techniques for soil data analysis to assist in enhanced land use and planning Offers geologists essential tactics for better environmental management by providing a comprehensive analysis of the physical features of soil Companion website includes access to the latest technological advancements previously unpublished in any other comprehensive source geomorphometry software DEM data sources and applications Surveyor (Theory) - II Mr. Rohit Manglik, 2024-05-18

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Applications of Geomatics in Civil Engineering Jayanta Kumar Ghosh, Irineu da Silva, 2019-06-19 This book comprises select proceedings of the First International Conference on Geomatics in Civil Engineering ICGCE 2018 This book presents latest research on applications of geomatics engineering in different domains of civil engineering like structural engineering geotechnical engineering hydraulic and water resources engineering environmental engineering and transportation

engineering It also covers miscellaneous applications of geomatics in a wide range of technical and societal problems making use of geospatial information engineering principles and relational data structures involving measurement sciences The book proves to be very useful for the scientific and engineering community working in the field of geomatics and geospatial technology *GIS and Geocomputation for Water Resource Science and Engineering* Barnali Dixon,Venkatesh Uddameri,2016-02-08 GIS and Geocomputation for Water Resource Science and Engineering not only provides a comprehensive introduction to the fundamentals of geographic information systems but also demonstrates how GIS and mathematical models can be integrated to develop spatial decision support systems to support water resources planning management and engineering The book uses a hands on active learning approach to introduce fundamental concepts and numerous case studies are provided to reinforce learning and demonstrate practical aspects The benefits and challenges of using GIS in environmental and water resources fields are clearly tackled in this book demonstrating how these technologies can be used to harness increasingly available digital data to develop spatially oriented sustainable solutions In addition to providing a strong grounding on fundamentals the book also demonstrates how GIS can be combined with traditional physics based and statistical models as well as information theoretic tools like neural networks and fuzzy set theory

Fundamentals of Civil Engineering: Principles, Practices, and Applications Anasuya Mondal ,Subhankar Dey,2025-05-08 **GIS Methodologies for Developing Conservation Strategies** Basil G. Savitsky,Thomas E. Lacher, Jr.,1998-04-28 Tropical habitats may contain more than a third of the world s plant and animal species Costa Rica alone is home to one of the highest levels of biodiversity per unit area in the world and stands at center stage in worldwide conservation efforts Within such regions the use of state of the art digital mapping technologies sophisticated techniques that are relatively inexpensive and accessible represents the future of conservation planning and policy These methods which employ satellites to obtain visual data on landscapes allow environmental scientists to monitor encroachment on indigenous territories trace park boundaries through unmarked wilderness and identify wildlife habitats in regions where humans have limited access Focusing on the rich biodiversity of Costa Rica the contributors demonstrate the use of geographic information systems GIS to enhance conservation efforts They give an overview of the spatial nature of conservation and management and the current status of digital mapping in Costa Rica a review of the basic principles behind digital mapping technologies a series of case studies using these technologies at a variety of scales and for a range of conservation and management activities and the results of the Costa Rican gap analysis project GIS Methodologies for Developing Conservation Strategies provides powerful tools for those involved in decision making about the natural environment particularly in developing nations like Costa Rica where such technologies have not yet been widely adopted For specialists in such areas as geography conservation biology and wildlife and natural resource management the combination of conceptual background and case examples make the book a crucial addition to the literature **Handbook of Hydrology** David R. Maidment,1993-02-22 An

all inclusive reference covering all practical aspects of hydrology Twenty nine chapters in four major sections I Hydrologic Cycle II Hydrologic Transport III Hydrologic Statistics IV Hydrologic Technology 500 illustrations Manual of Aerial Survey Roger E. Read, Ron Graham, 2002

Basic Surveying Raymond Paul, Walter Whyte, 2012-09-10 The primary aim of this book is to provide a guide to current practice and equipment for non specialist surveyors in the various professions involved in the construction industry and the environment It is suitable for students preparing for degrees and diplomas in architecture building building surveying quantity surveying estate management and town planning and environmental studies It is also of value to engineers who are not specialising in engineering surveying This book has been thoroughly revised to include new topics such as OS digital mapping standard deviation and standard error global positioning systems transition and vertical curves Walter Whyte was born in New Zealand of Scottish parents and educated in Scotland He worked on site and building surveys in Scotland He worked on site and building surveys in Scotland then on road survey and setting out in the North Nyanza and Uasin Gishu Provinces of Kenya and as a road engineer in British Southern Cameroons and Northern Nigeria De Montford University in the UK and latterly at City University Hong Kong Raymond E Paul has been professionally involved in surveying for over 40 years as a land and cartographical surveyor senior lecturer and author He has a wealth of practical experience and an awareness of the needs of the intended users of this book from all corners of the globe

Geomatics Applied to Civil Engineering Irineu da Silva, Paulo C. L. Segantine, 2025-05-13 This textbook deals jointly with theoretical and practical concepts within geomatics in civil engineering based on the global understanding of its use Written by civil engineers with professional backgrounds in geomatics the book has a number of unique characteristics including analysis of geodetic references and their coordinate systems to allow their conversions and applications taking into account the local topographic plan analysis of the measurements of directions angles and distances inserting them into the concepts of practical use of modern measuring instruments detailed description of the main components of measurement instruments used in geomatics discussion of instrumentation errors and their implications and a complete study of UTM Projection System and its variants equations and practical application in civil engineering projects For students and instructors and practitioners the subjects covered in the book are organized to cover most topics related to the disciplines of surveying or geomatics studied in civil engineering courses It is entirely based on adjustment computation for spatial data analysis including coordinate geometry and traverse computation To this end an entire chapter is devoted to adjustment computation based on matrix theory to help readers understand its applications in spatial data analysis throughout the book s chapters including chapters on modern technologies such as conventional and UAV based digital photogrammetry digital terrain modelling terrestrial laser scanning and BIM

Advances in Information Technology in Civil and Building Engineering Sebastian Skatulla, Hans Beushausen, 2023-09-29 This book gathers the latest advances innovations and applications in the field of information technology in civil and building engineering presented at the 19th International

Conference on Computing in Civil and Building Engineering ICCCB E held in Cape Town South Africa on October 26 28 2022
It covers highly diverse topics such as BIM construction information modeling knowledge management GIS GPS laser scanning sensors monitoring VR AR computer aided construction product and process modeling big data and IoT cooperative design mobile computing simulation structural health monitoring computer aided structural control and analysis ICT in geotechnical engineering computational mechanics asset management maintenance urban planning facility management and smart cities Written by leading researchers and engineers and selected by means of a rigorous international peer review process the contributions highlight numerous exciting ideas that will spur novel research directions and foster multidisciplinary collaborations

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